

08/15/00
JCS53 U.S. PTO

08-16-00

H

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Docket No.: 00-076-TAP

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Transmitted herewith for filing is the patent application of Inventor(s):

Robert S. Creager, and James Ries

For: Automated Hardware Sensing And Library Configuration

Enclosed are also:

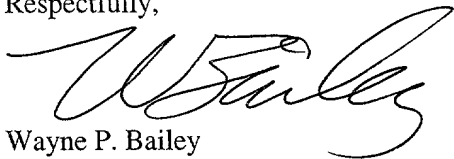
- ☒ 27 Pages of Specification including an Abstract
- ☒ 10 Pages of Claims
- ☒ 9 Sheet(s) of Drawings
- ☒ A Declaration and Power of Attorney
- ☒ Form PTO 1595 and Assignment of the invention to Storage Technology Corporation

CLAIMS AS FILED

FOR	Number Filed		Number Extra		Rate		Basic Fee (\$690)
Total Claims	47	-20 =	27	X	\$ 18	=	\$ 486.00
Independent Claims	6	-3 =	3	X	\$ 78	=	\$ 234.00
Multiple Dependent Claims	0			X	\$260	=	\$ 0.00
Total Filing Fee							= \$1,410.00

- ☒ Please charge \$1,410.00 to Storage Technology Corporation Deposit Account No. 19-4545.
- ☒ The Commissioner is hereby authorized to charge payment of the following fees associated with the communication, or credit any overpayments to Storage Technology Corporation Deposit Account No. 19-4545. (A duplicate copy of this sheet is enclosed.)
 - ☒ Any additional filing fees required under 37CFR § 1.16.
 - ☒ Any patent application processing fees under 37CFR § 1.17.

Respectfully,



Wayne P. Bailey
Registration No. 34,289
STORAGE TECHNOLOGY CORPORATION
One StorageTek Drive
Louisville, Colorado 80028-4309
Telephone: (303) 673-8223

JCS57 U.S. PTO
09/638368
08/15/00

08/15/00 09/638368

CERTIFICATE OF MAILING BY "EXPRESS MAIL"



"Express Mail" mailing label number EL370106602US. Date of deposit August 15, 2000. I hereby certify that the papers or fees listed below are being deposited with the United States Postal Service by "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

Stephanie Klepp
Printed Name


Signature

ENCLOSED are the following documents, being sent by "Express Mail":

- ☐ Patent Application Fee Transmittal (in duplicate)
- ☐ Declaration and Power of Attorney (2 pages)
- ☐ Assignment (1 page)
- ☐ Form PTO 1595 Recordation Form Cover Sheet (in duplicate)
- ☐ Specification, Claims and Abstract (29 pages)
- ☐ Drawings (9 pages)
- ☐ Return postcard

Docket No. 00-076-TAP

AUTOMATED HARDWARE SENSING AND LIBRARY CONFIGURATION

BACKGROUND OF THE INVENTION

5 1. Technical Field:

The present invention relates generally to the automatic configuration of a storage device and more particularly to a method and apparatus for automatically configuring a robotic media storage library without user
10 intervention.

2. Description of Related Art:

Robotic media storage libraries are devices for providing automated access to a large collection of data stored on multiple physical storage media, such as magnetic tape cartridges or compact discs. Robotic media storage libraries generally contain a plurality of storage locations for physical media, one or more media drives for reading or writing physical media and a manipulator for moving physical media from a storage location to a drive and back. Robotic media storage libraries may have special storage locations designated for certain purposes, such as serving as a temporary storage location while two pieces of media are being swapped or for adding or removing physical media from the library.

Just like automobiles, which come in different colors with different selections of features, these libraries allow for a great deal of variation and customizability. For instance two libraries from the same manufacturer may be a different size, have a

Docket No. 00-076-TAP

different capacity, have optional features, etc. It is also possible to make modifications to an existing library, to increase its capacity, for instance. This becomes a problem for the software that must control the library, however, because the control software must be aware of all the specific characteristics of the library before controlling it.

Configuration software must be used to set up the control software to operate the library. This software can become very complex to use, because the user of the software must navigate through a barrage of different configuration options, and an inexperienced user may not be completely aware of the hardware characteristics of his or her particular library. This makes configuration a frustrating and time-consuming process, particularly when the library has to be reconfigured by people other than the original installers of the library.

Therefore, it would be advantageous to have a method and apparatus for configuring a robotic media storage library automatically, without a user having to manually set configuration options.

005780" 004500

Docket No. 00-076-TAP

SUMMARY OF THE INVENTION

The present invention provides a method and apparatus for automatically configuring a robotic storage media library, which may store tape cartridges, compact discs, floppy disks, or other storage media. Upon initialization or re-initialization of the library, configuration software detects the hardware characteristics of the library from specially designed hardware. The software then uses these characteristics to make configuration settings in the software that controls the library. These characteristics include but are not limited to the type/model and capacity of the library; the number, type, and arrangement of media drives in the library; and the number and capacity of access ports for adding or removing media from the library. The invention makes it possible to have one piece of storage library control software that is usable in a variety of different models/types and configurations of libraries.

Docket No. 00-076-TAP

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

10 **Figure 1** is an exemplary cutaway drawing of a robotic tape library showing the inner workings of the device;

Figure 2 is an exemplary drawing of a robotic tape manipulator;

15 **Figure 3** is an exemplary diagram of the internal layout of a tape library;

Figure 4 is an exemplary block diagram of a control system in accordance with the present invention;

20 **Figure 5** is a flowchart outlining an exemplary operation for library self-configuration;

Figure 6 is a flowchart outlining an exemplary operation for determining storage array size and type;

Figure 7 is a block diagram depicting a column of drives;

25 **Figure 7A** is a flowchart outlining an exemplary operation for drive detection in accordance with the present invention; and

30 **Figure 8** is an exemplary schematic depicting one possible embodiment of a hardware sensor usable in the present invention.

005780" B9E9E960

Docket No. 00-076-TAP

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 depicts a robotic storage media library **100**. This particular library **100** stores information on magnetic tape cartridges. The cartridges are stored in one or more storage arrays **110**, which are divided into cells **115**, each cell **115** storing one cartridge. The storage arrays **110** are arranged in the shape of a partial cylinder. The library **100** also contains one or more drives **120** for retrieving data from the cartridges. A manipulator **130** transfers tapes between the storage arrays **110** and the drives **120**.

Also included in the library is a cartridge access port (CAP) **140**. The CAP **140** allows cartridges to be added or removed from the library **100** without interfering with the movements of the manipulator **130** or opening the door **150** of the library **100**. The manipulator **130** can remove a cartridge from the storage arrays **110** and place it in the CAP **140** to be removed from the library **100**, and the manipulator **130** can also retrieve a tape placed within the CAP **140** and store it in the storage arrays **110**. There may be more than one CAP in a library, and different CAPs may hold a differing number of tapes. A small control panel **160** allows an operator to start, stop or reset the library **100** and allows an operator to remove or add a cartridge using the CAP **140**.

Not depicted in **Figure 1** is a processor (**400** in **Figure 4**), which coordinates and controls the library. The processor **400** may be integrated into the library **100**, or it may be a separate unit coupled to the library **100**.

Docket No. 00-076-TAP

Figure 2 shows the manipulator **130** in more detail. A motor **200**, belt **205**, and pulley **207** allow the manipulator **130** to move rotationally in the " θ direction" **210**. Another motor **220** moves a carriage **240** along a track **245** spanning the length of the manipulator **130** in the " Z direction" **230** (vertically). The motors **200**, **220** are equipped with tachometers (not shown) to measure how far the manipulator is moved. The tachometers may reset to show zero distance and may be read electronically.

A hand/camera assembly **250**, mounted to the carriage **240**, picks up and deposits cartridges. The hand/camera assembly **250** is also equipped with a small video camera for reading identification barcodes printed on cartridges. Being able to read the barcodes makes it possible to perform an audit of all of the cartridges in the library.

An end stop **260**, mounted in one of several mounting holes **270**, physically limits the rotational movement of the manipulator **130**. The required range of rotational movement of the manipulator **130** is a function of the number of storage arrays **110** (**Figure 1**) installed. If more storage arrays are installed, a greater range of movement is necessary. The end stop **260** is installed to limit the available movement of the manipulator **130** to that necessary to reach the storage arrays **110**, drives **120**, and CAPs **140** (**Figure 1**).

Figure 3 shows the arrangement of storage arrays **110**, drives **120**, and CAPs **140** within the library **100** from the perspective of the manipulator **130**, with the Z direction represented as the vertical and the θ direction

005760-094000

Docket No. 00-076-TAP

represented as the horizontal. The storage arrays 110 are divided into cells 310. Certain cells have special attributes and are known as unique cells 350. These cells are identified according to the legend at the bottom right corner of **Figure 3**. A swap cell 330 is used as a temporary storage location for a cartridge, when that cartridge is being exchanged with another cartridge. A reserved cell 340 is used for storing a special cartridge, such as a cleaning cartridge.

Drives 120 are arranged in columns. Each column has a maximum number of drives available to it, in this case ten drives are the maximum. A library 100 may have several columns of drives 120.

A primary feature of the present invention is specially designed hardware for communicating attributes of the hardware to a controlling processor (computer). **Figure 4** shows two ways in which a processor 400 residing on a bus 410 can obtain information from hardware components 420, 440, 450.

One method is for the component 420 to be a bus peripheral. In this method, the component 420 is given a bus address. When the processor 400 needs to obtain information from the component 420, the processor 400 uses the bus 410 to request read information from the location specified by the bus address (that is, the component 420), just as if the component 420 were a memory location.

The other method is for the processor 400 to communicate a query to a component 440 and receive a reply. This can be accomplished by connecting an

Docket No. 00-076-TAP

input/output (I/O) adapter **430** between the bus **410** and the component **440**. The processor **400** writes the query through the bus **410** to the I/O adapter **430**, which then relays the query to the component **440**. The component **440** sends a reply to the I/O adapter **430**, which can then be read by the processor **400** through the bus **410**. The I/O adapter can, optionally, notify the processor **400** that the reply is available, by sending a signal over an interrupt request line (IRQ).

The present invention provides automatic configuration of the software controlling a robotic media storage library **100** (**Figure 1**). Rather than requiring a user of the library **100** to enter configuration information manually into the software, the present invention allows the software to acquire that information for itself. This is done by having the software detect configuration from the library hardware. The library hardware is designed to detect and report information about itself to the software. This configuration information may then be stored as a configuration file for use by the processor **400** in controlling the operation of the library. In this way, the library is automatically configured based on the information obtained from the library hardware.

Figure 5 is a flowchart outlining an exemplary operation of the present invention when acquiring information from the hardware and using it to configure the library **100**. This sequence of steps should be executed when the library **100** is first powered on and whenever the library **100** is reinitialized.

Docket No. 00-076-TAP

First, the library type or model is determined (step 500) and the size of the library is determined (step 510). This procedure, described in **Figure 6**, involves measuring the range of movement available to the
5 manipulator **130**. The range of rotational movement indicates the size of the library in number of storage arrays, since the storage arrays **110** are placed side-by-side. The range of vertical movement indicates the type or model of library being used, since different types or
10 models of library will have differing heights (as will their storage arrays).

Next, three independent sequences of steps take place, which may be performed in parallel or in series. The first sequence involves determining the number of
15 columns of drives (step **520**), determining the number of drives in each column (step **530**), and determining which types of drives are in each location (step **540**). These operations are described in more detail in **Figure 7**.

The second sequence of operations is to determine
20 the type and location of the unique cartridges (step **550**). This is done by using the video camera on the manipulator **130** (**Figure 1**) to audit the cartridges. The unique cartridges are marked with special bar codes to identify them. To audit the cartridges, the manipulator
25 **130** sweeps over all of the cartridges, making note of the locations of the cartridges carrying the special barcodes of the unique cartridges. This process is described in, for example, U.S. Patent 5,323,327, which is incorporated herein by reference.

30 The third sequence of operations is to determine the number of CAPs **140** (**Figure 1**) and the capacity of the

005780" 00500

Docket No. 00-076-TAP

CAPs 140. The capacity of the CAPs 140 is a function of the type of library 100 being used. Since the library was determined by measuring the vertical range of the manipulator 130, the capacity of the CAPs can be
5 determined simply by matching the library type to its respective CAP capacity. The number of CAPs 140 in the library 100 can be detected by using a hardware existence sensor. A hardware existence sensor tells whether a piece of hardware is present within the library 100. It
10 returns a bit, which is zero if the device is not present and one if it is. One exemplary embodiment of a hardware existence sensor is described in **Figure 8**.

Finally, after these three sequences of operations collect their data, the software controlling the library
15 is configured to operate in accordance with the data collected (step 580). Configuration involves resolving such issues as which cells are for unique cartridges, where to place cartridges in a CAP, how many cartridges can be removed or added at once, location and type of
20 drives installed, and the like.

Figure 6 is a flowchart depicting the sequence of steps involved in determining the library type and size. As shown in **Figure 6**, first the manipulator 130 (**Figure 1**) is moved as far as it can go vertically and
25 rotationally in one direction (step 600), to the extreme upper right of its range of motion, for instance. Next, the tachometers described in reference to **Figure 2** are set to zero distance (step 610). After the tachometers are zeroed, the manipulator is extended through its
30 entire range of motion to the opposite extreme of its

Docket No. 00-076-TAP

range (step 620). This would be the extreme lower left, in the above example.

At this point, the tachometers are read (step 630). The readings are then matched against a table of expected values for various library types and sizes (step 640). The table can be stored in non-volatile memory for direct access by the processor 400 (Figure 4). Alternately, the table can be stored in a compressed format in non-volatile memory and copied in decompressed form into volatile memory at library initialization. If the readings match a particular combination of type and size, the match is reported (step 650), otherwise the lack of a match is treated as an error (step 660). In the event of an error, the above process may be repeated a number of times to compensate for an inaccuracy in measurement.

An optional rotational sweep of the manipulator 130 along the bottom of the library 100 can be performed after determining the library size and type. This optional sweep will detect foreign objects that may be present on the inside floor of the library 100. A foreign object acts like an end stop, obstructing the path of the manipulator 130. If the available range of rotational motion in this optional sweep does not match the previously measured range, a foreign object is probably present within the library 100 and should be removed. An indication to the operator of the presence of the foreign object may be made via the operator panel, for example.

An alternative method of determining library size or type that may be employed independently of or in conjunction with the aforementioned manipulator sweep

Docket No. 00-076-TAP

procedure is to use a jumper wire or other form of switch to set an electrical signal to correspond to a particular value of binary digit (0 or 1). This binary digit, or bit, is detectable by a processor 400 through a hardware existence sensor. A predetermined combination of binary digits can be associated with a library type or size in such a way that the processor 400 will be made aware of the type or size of the library 100 by matching the combination of binary digits against a table in which each combination corresponds to a particular library type or size. As with the previously mentioned table, this table can be stored in non-volatile memory for direct access or stored compressed in non-volatile memory and accessed in decompressed form through a copy in volatile memory.

Once the library type and size have been detected, the drive column count, drive count, and drive locations and types can be determined from the hardware. **Figure 7** depicts the connection layout of a column 700 of drives 120. Each column has an associated multiplexing card 730. The multiplexing card 730 allows the library's processor 400 to access the different drives 120 of the column 700 through a single data port 740 of the processor 400. The processor 400 specifies an address on an address bus 720, which is fed into the multiplexing card 730. The multiplexing card 730 then selects a drive 120 from the column 700 according to the address. The processor 400 can then communicate with the selected drive 120 through its data port 740.

Docket No. 00-076-TAP

The number of drive columns is detected **520** (**Figure 5**) by using hardware existence sensors (described in **Figure 8**) to detect the number of multiplexing cards **730**. The number of multiplexing cards **730** is equal to the
5 number of drive columns **700**, since each drive column **700** must have a multiplexing card.

Each drive column **700** has a predefined set of physical locations to which a drive **120** may be connected. Not all of the locations need be filled, however. Thus,
10 to determine how many drives are in each column **530** (**Figure 5**), each individual drive must be detected. This is done by using a hardware existence sensor (described in **Figure 8**) for each drive. The information reported by each hardware existence sensor is multiplexed through the
15 multiplexing card **730**, just as other information is.

Figure 7A, when examined with **Figure 7**, outlines an exemplary operation of the invention when determining how many drives **120**, are in a column **700**, which locations those drives **120** are in, and what type of drive **120** each
20 is. First the multiplexing card **730** is set to the address of the first location in the column (step **701**). The hardware existence sensor bit for that location is then read by the processor **400** through the multiplexing card **730**. If the bit is set, that is if there is a drive
25 **120** in the location (step **711**), the processor **400** attempts to communicate with the drive **120** using one of a series of protocols (step **721**), where each protocol corresponds to a different type of drive. If the communication was successful (step **731**), then the
30 processor **400** queries the drive **120** to ascertain its

005780" B9E2E960

Docket No. 00-076-TAP

type. The drive 120 responds by reporting its type to the processor 400, which records the information (step 741). If the protocol was not successful (step 731), the processor 400 checks to see if there is another protocol
5 that could be used (step 771). If there is, then communication is attempted with that protocol (step 721). If not, an error is reported (step 781).

After one location has been dealt with, the processor 400 determines if there are more locations to
10 be checked (step 751). If there are, then the address of the multiplexing card 730 is set to the next location (step 761), and the next location is checked for the existence of a drive (step 711). If not, then the procedure terminates (step 791).

15 Detecting the presence of a piece of hardware within the library 100 requires the use of some kind of detection sensor or circuit. **Figure 8** shows how a hardware existence sensor 805 can be implemented. The hardware component 800 to be detected is built in such a
20 way that when it is physically connected to the main structure of the library 810, a jumper 820 attached to the hardware component 800 connects across two terminals 830. Thus, if the hardware component 800 is present within the library 100 (that is, it is connected), the
25 jumper 820 will connect the terminals 830.

The circuitry of the hardware existence sensor 805 in **Figure 8** works as follows. When the hardware component is not connected to the main structure 810, the capacitor 840 is charged to the voltage level (Vcc) of
30 the power supply 860 through a pull-up resistor 850.

005780" 034500

Docket No. 00-076-TAP

Since the capacitor **840** is charged to Vcc (high), the output **895** of the Schmitt trigger inverter **890** is brought low. In other words, the output **895** reads as a zero bit (hardware component **800** missing).

5 When the hardware component **800** is connected, the jumper **820** shorts the two terminals **830**. This causes the capacitor **840** to gradually discharge itself through a drain resistor **880**. After the capacitor **840** drains sufficiently, the voltage applied to the Schmitt trigger
10 inverter **890** will be low. That will cause the output **895** of the Schmitt trigger inverter **890** to be brought high. Thus, the output **895** will read as a one bit (hardware component **800** present).

 The combination of the resistors **850**, **880**, capacitor
15 **840**, and Schmitt trigger inverter **890** prevent the output **895** from reading an erroneous result in the event of a momentary disconnection of the jumper **820** and terminals **830** (such as might happen if the library **100** suffers a physical blow or a quick power failure).

20 A standard parallel interface integrated circuit such as a MOTOROLA 68230 parallel interface/timer can be connected to the output **895** to make the hardware existence sensor **805** act as a bus peripheral and communicate with the processor **400** using standard memory
25 access techniques as in **Figure 4**.

 In summary, the disclosed invention provides the ability to configure a robotic storage media library without manual entry of configuration data. This greatly simplifies the process of installing or re-initializing
30 such a library. Upgrades and modifications to a library

005780" 39E3E360

Docket No. 00-076-TAP

are made simpler, because the library will simply reconfigure itself.

In addition, the invention also simplifies the process of writing configuration software, because it
5 obviates the need to write user interface code for entering configuration data or to modify that code when new software versions appear. Because less user interaction is needed with the present invention, fewer lines of operating instructions need be printed.

10 It is important to note that while the present invention has been described in the context of a fully functioning data processing system, those of ordinary skill in the art will appreciate that the processes of the present invention are capable of being distributed in
15 a form of a computer readable medium of instructions and a variety of forms and that the present invention applies equally regardless of the particular type of signal bearing media actually used to carry out the distribution. Examples of computer readable media
20 include recordable-type media such a floppy disk, a hard disk drive, a RAM, and CD-ROMs and transmission-type media such as digital and analog communications links.

The description of the present invention has been presented for purposes of illustration and description,
25 but is not limited to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. The embodiment was chosen and described in order to best explain the principles of the invention the
30 practical application to enable others of ordinary skill in the art to understand the invention for various

005780" 09E9E960

embodiments with various modifications as are suited to the particular use contemplated.

Docket No. 00-076-TAP

CLAIMS:

What is claimed is:

1. A method of configuring a robotic storage media
5 library, the method comprising:
 - (a) automatically retrieving hardware characteristics from a hardware component associated with the robotic storage media library; and
 - (b) configuring the robotic storage media library
10 based upon the hardware characteristics.
2. The method of claim 1, wherein the robotic storage media library is a robotic tape library.
- 15 3. The method of claim 1, wherein the hardware characteristics comprise existence information, wherein the existence information tells whether an optional hardware device exists within the robotic storage media library.
- 20 4. The method of claim 3, wherein the hardware component is a hardware existence sensor.
5. The method of claim 1, wherein the hardware
25 component comprises a storage media identifier device.
6. The method of claim 5, wherein the storage media identifier device comprises one of a video camera barcode reader and a laser barcode reader.

Docket No. 00-076-TAP

7. The method of claim 1, wherein the hardware characteristics comprise at least one of a library size, a library type, drive column information, drive installation location, a drive type, library unique media
5 information and cartridge access port information.

8. The method of claim 7, wherein the cartridge access port information comprises one of a cartridge access port count and a cartridge access port capacity.
10

9. The method of claim 7, wherein the drive column information comprises one of a drive column count and a drive column capacity.

10. The method of claim 7, wherein the library unique media information comprises one of a unique media location and a unique media type.
15

11. The method of claim 1, comprising the step of:
20 (c) accessing the hardware component through a bus.

12. The method of claim 1, comprising the step of:
(c) accessing the hardware component through an input/output adaptor.
25

13. The method of claim 1, wherein the hardware component is a storage media drive.

14. The method of claim 1, wherein the hardware
30 component is a robotic storage media manipulator.

005766-004500

Docket No. 00-076-TAP

15. The method of claim 1, comprising the step of:

(c) executing step (a) and step (b) upon initialization of the robotic storage media library.

5 16. A method of determining storage array characteristics of a storage array with which a robotic storage media manipulator is associated so as to access storage media, the method comprising:

(a) automatically measuring an extent of possible
10 movement of the robotic storage media manipulator; and

(b) reporting storage array characteristics based upon the extent of possible movement of the robotic storage media manipulator.

15 17. The method of claim 16, wherein step (a) comprises
the steps of:

(c) moving the robotic storage media manipulator through the extent of possible movement;

(d) reading data from a tachometer associated with
20 the storage media manipulator; and

(e) calculating the extent of possible movement from the data.

18. The method of claim 16, wherein the storage array
25 characteristics comprise one of a storage array size and
a storage array type.

19. The method of claim 16, wherein the extent of possible movement is the distance the robotic storage media manipulator can travel along an axis.

Docket No. 00-076-TAP

20. The method of claim 19, wherein the axis is at least one of axis is a vertical (Z) axis and a cylindrical rotational (θ) axis.

5 21. The method of claim 20, wherein the extent of possible movement is defined by the physical presence of at least one end stop in a path of the robotic storage media manipulator.

10 22. The method of claim 16, comprising the step of:
(c) matching the extent of possible movement against a supported value; and
(d) identifying a storage array size based upon the supported value.

15 23. A robotic storage media library controlled by a computer running library software, the library comprising:
a storage array, wherein the storage array stores
20 media;
a robotic manipulator;
measuring means for measuring length of motion of the robotic manipulator; and
at least one media drive, wherein the robotic
25 manipulator moves media to and from the storage array and to and from the at least one media drive; at initialization of the library, the manipulator moves through its full range of motion and the measuring means makes a measurement of the range; the computer reads the
30 measurement, and the library software matches the measurement with a predefined value to determine

005780" 00332560

Docket No. 00-076-TAP

characteristics of the storage array.

24. The library of claim 23, wherein the characteristics
comprise at least one of a storage array type and a
5 storage array size.

25. The library of claim 23, wherein the measurement
means comprises a tachometer.

10 26. The library of claim 23, comprising at least one end
stop, wherein the motion of the manipulator is limited by
the end stop.

27. A robotic storage media library controlled by a
15 computer running library software, the library
comprising:

a storage array, wherein the storage array stores
media;

a robotic manipulator;
20 a media drive; and

a hardware sensor, wherein the robotic manipulator
moves media to and from the storage array and to and from
the at least one media drive; the hardware sensor senses
whether a hardware component is connected to the library,
25 and the computer recognizes whether the hardware
component is connected to the library from the sensor.

28. The library of claim 27, wherein the hardware
component is at least one of a cartridge access port, a
30 multiplexing card, a switch and at least one media drive.

0057333-004000
DOESTB-0057333

Docket No. 00-076-TAP

29. A computer program product in a computer readable medium, comprising:

first instructions for retrieving hardware characteristics from a hardware component, wherein the hardware component is comprised of a robotic storage media library; and

second instructions for configuring the robotic storage media library based upon the hardware characteristics.

30. The computer program of claim 29, wherein the robotic storage media library is a robotic tape library.

31. The computer program of claim 29, wherein the hardware characteristics comprise existence information, wherein the existence information tells whether an optional hardware device exists within the robotic storage media library.

32. The computer program of claim 29, wherein the hardware component is one of a hardware component existence sensor and a storage media identifier device.

33. The computer program of claim 32, wherein the storage media identifier device comprises one of a video camera barcode reader and a laser barcode reader.

34. The computer program of claim 29, wherein the hardware characteristics comprise at least one of a library size, a library type, cartridge access port

005780-004500

Docket No. 00-076-TAP

information, drive column information, a drive installation location, and a drive type.

35. The computer program of claim 34, wherein the
5 cartridge access port information comprises one of a cartridge access port count, library unique media information and a cartridge access port capacity.

36. The computer program of claim 34, wherein the drive
10 column information comprises one of a drive column count and a drive column capacity.

37. The computer program of claim 35, wherein the
15 library unique media information comprises one of a unique media location and a unique media type.

38. The computer program of claim 29, comprising third
20 instructions for sending a query to the hardware component.

39. The computer program of claim 29, comprising third
instructions for accessing the hardware component through
a bus.

40. The computer program of claim 29, comprising third
25 instructions for accessing the hardware component through an input/output adaptor.

41. The computer program of claim 29, comprising third
30 instructions for executing the first instructions and the second instructions upon initialization of the robotic

005780" 00000000

Docket No. 00-076-TAP

storage media library.

42. A computer program product in a computer readable medium to be executed by computer controlling a robotic storage media manipulator, the manipulator positioned to access storage media stored on a storage array, the computer program comprising:

first instructions for measuring an extent of possible movement of the robotic storage media manipulator; and

second instructions for reporting storage array characteristics based upon the extent of possible movement of the robotic storage media manipulator.

43. The computer program of claim 42, wherein the first instructions comprise:

third instructions for moving the robotic storage media manipulator through the extent of possible movement;

fourth instructions for reading data from a tachometer associated with the storage media manipulator; and

fifth instructions for calculating the extent of possible movement from the data.

25

44. The computer program of claim 42, wherein the storage array characteristics comprise one of a storage array size and a storage array type.

45. The computer program of claim 42, wherein the extent of possible movement is the distance the robotic storage

005750-00000000

Docket No. 00-076-TAP

media manipulator can travel along an axis.

46. The computer program of claim 45, wherein the axis
is at least one of a vertical (Z) axis and a cylindrical
5 rotational (θ) axis.

47. The computer program of claim 42, further
comprising:

third instructions for matching the extent of
10 possible movement against a supported value; and
fourth instructions for identifying a storage array
size based upon the supported value.

005733-034900

5

AUTOMATED HARDWARE SENSING AND LIBRARY CONFIGURATION

A method and apparatus for automatically configuring a robotic storage media library is disclosed. The disclosed invention utilizes software to interpret signals from specially designed hardware to determine the hardware characteristics of the library at startup. The software then uses these characteristics to automatically configure the library without user intervention.

0633363 PAT. 2005

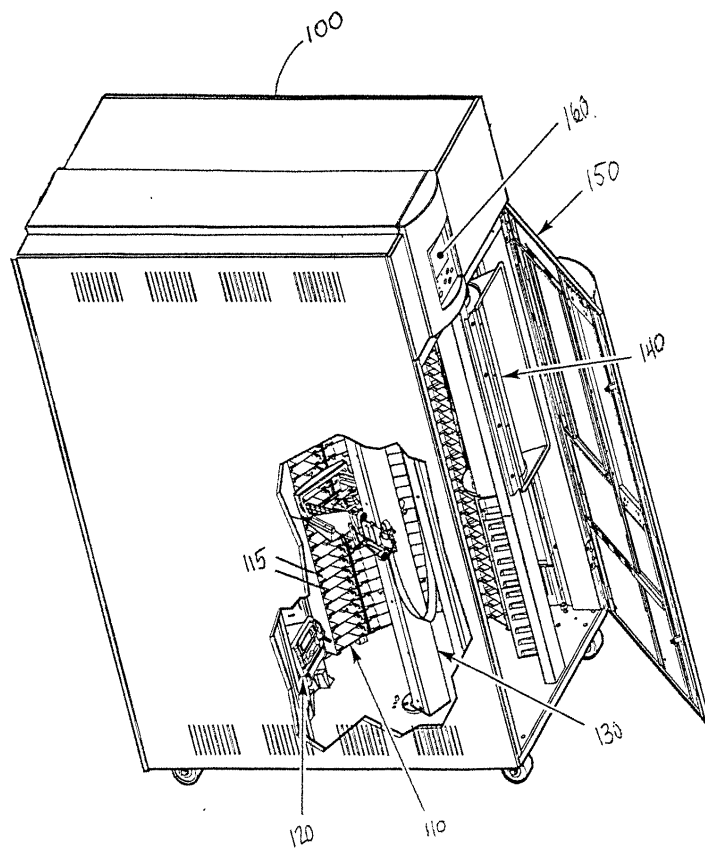


FIG. 1

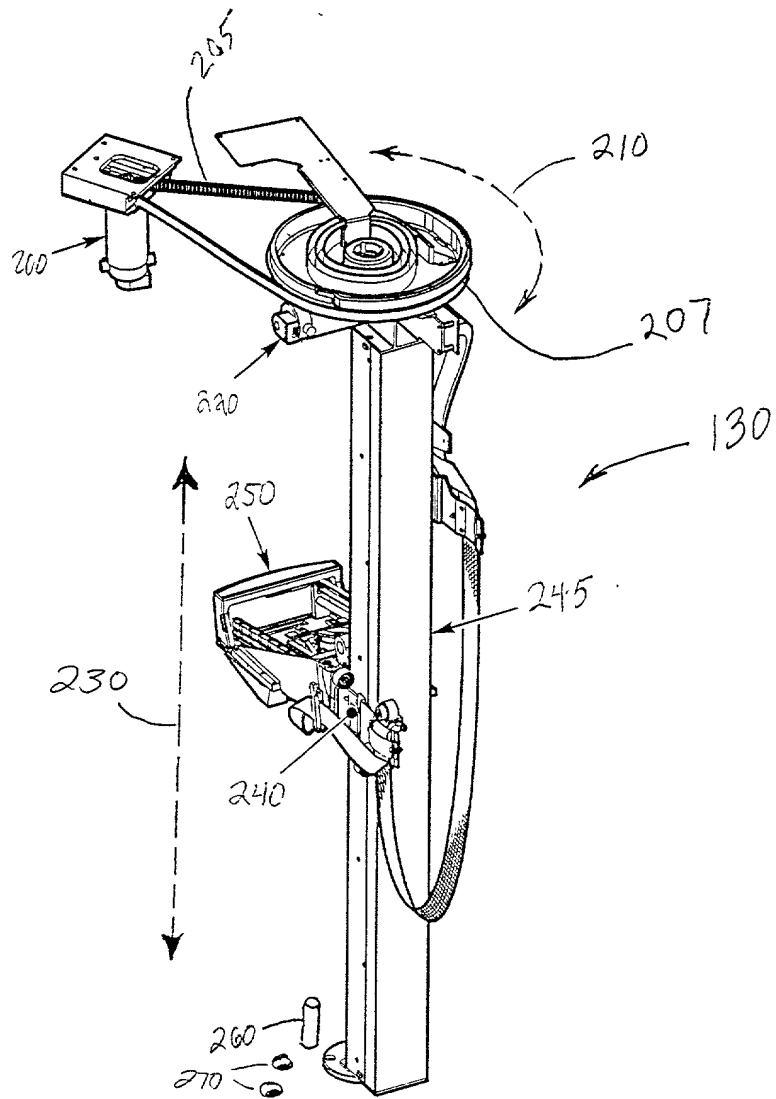
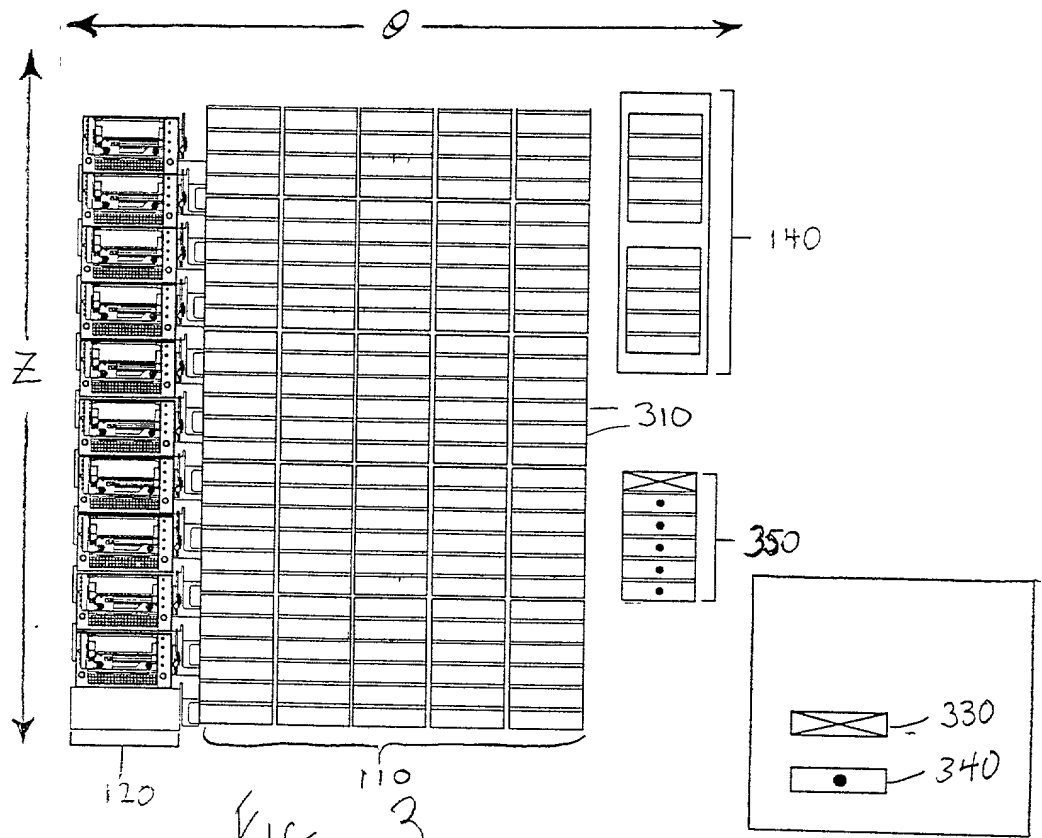


FIG. 2

0057.20" 03E0E960



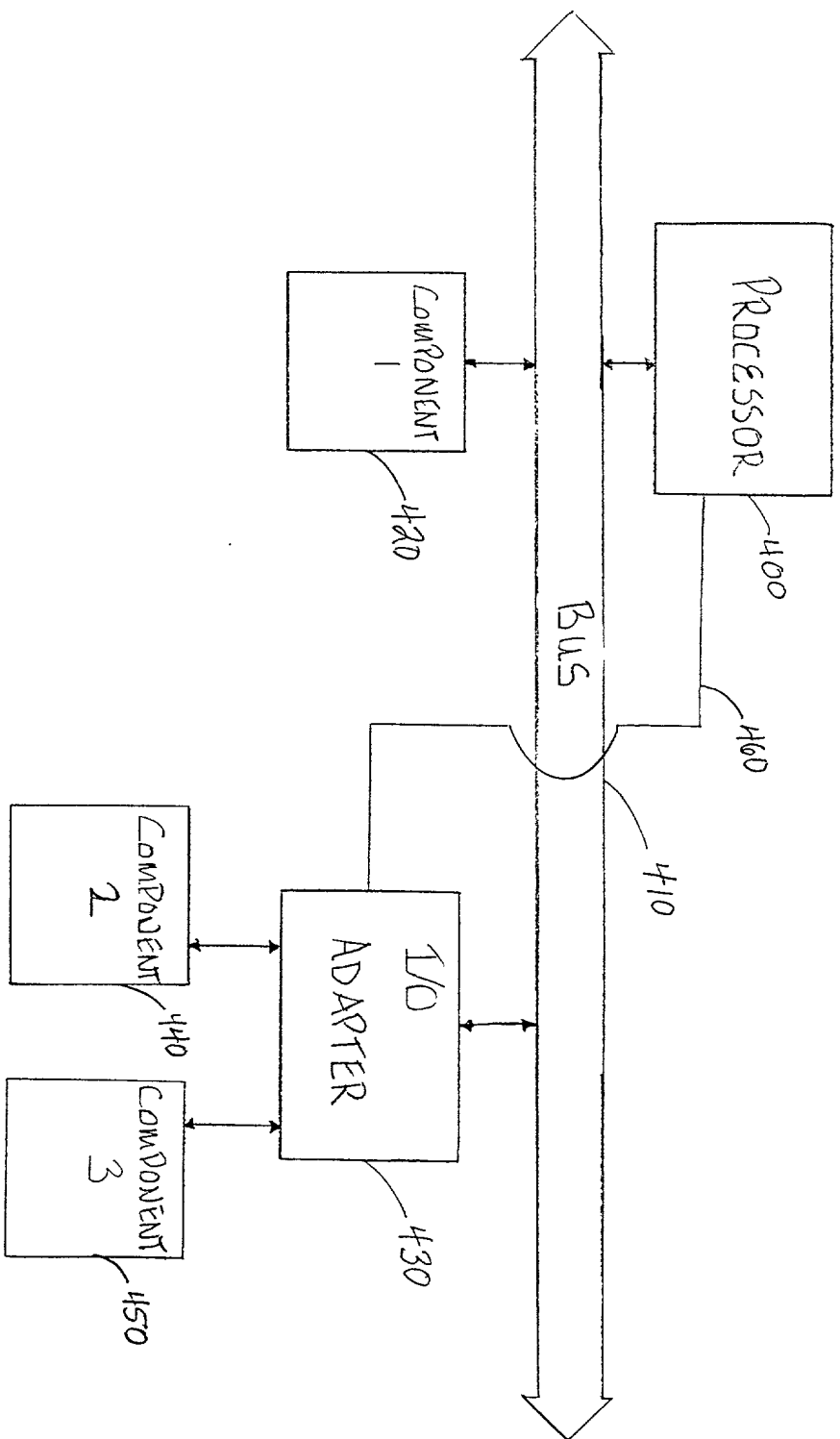
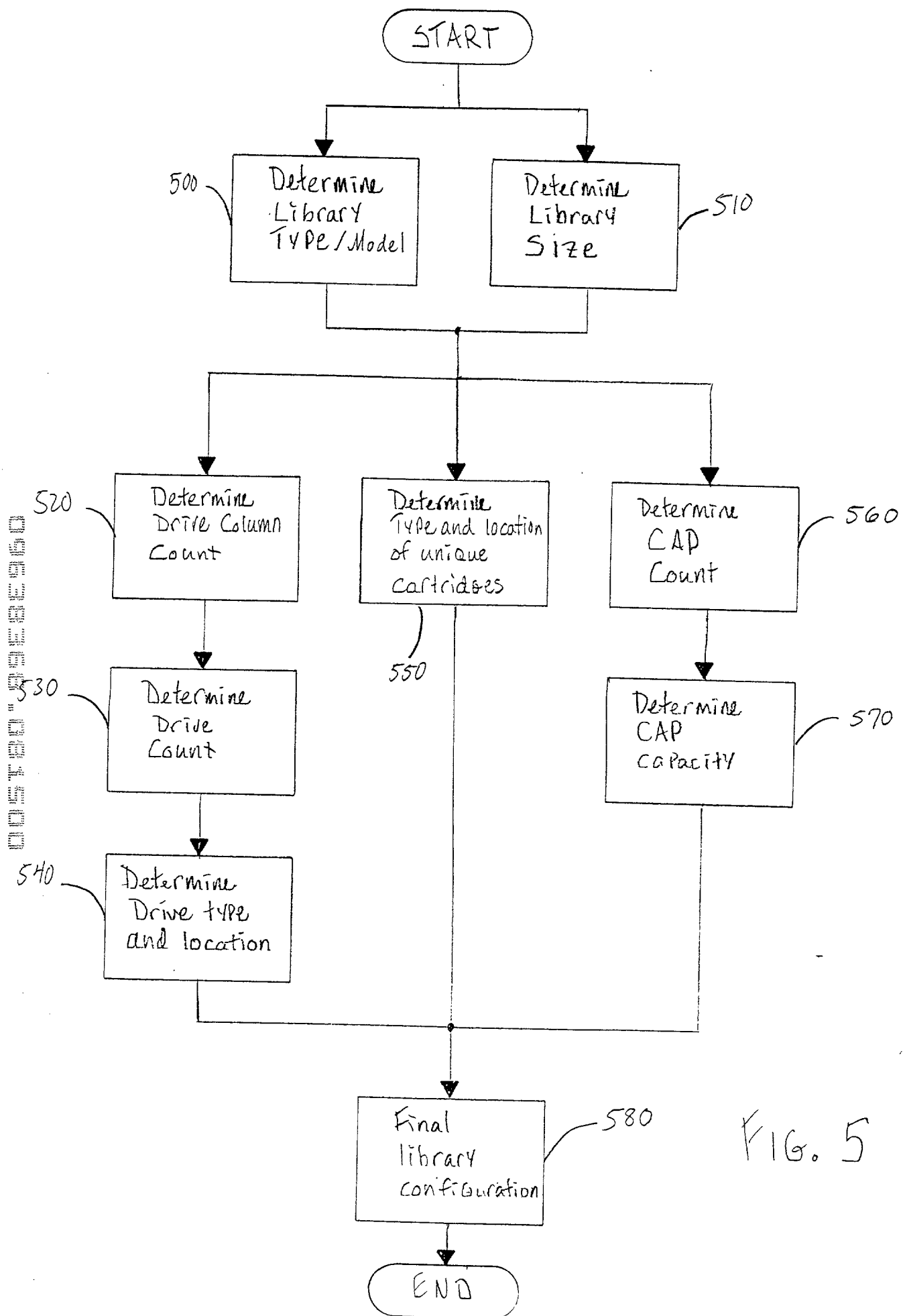
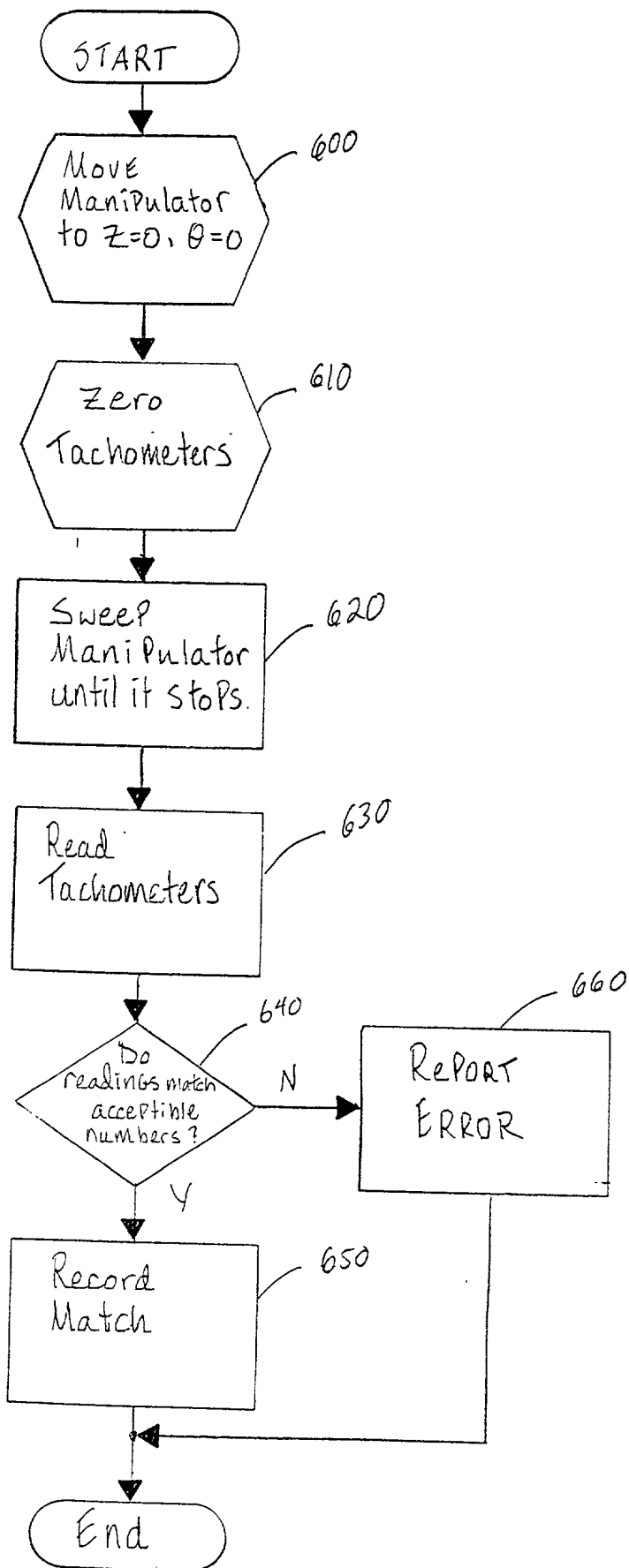


FIG. 4



005720" 2352560

FIG. 6



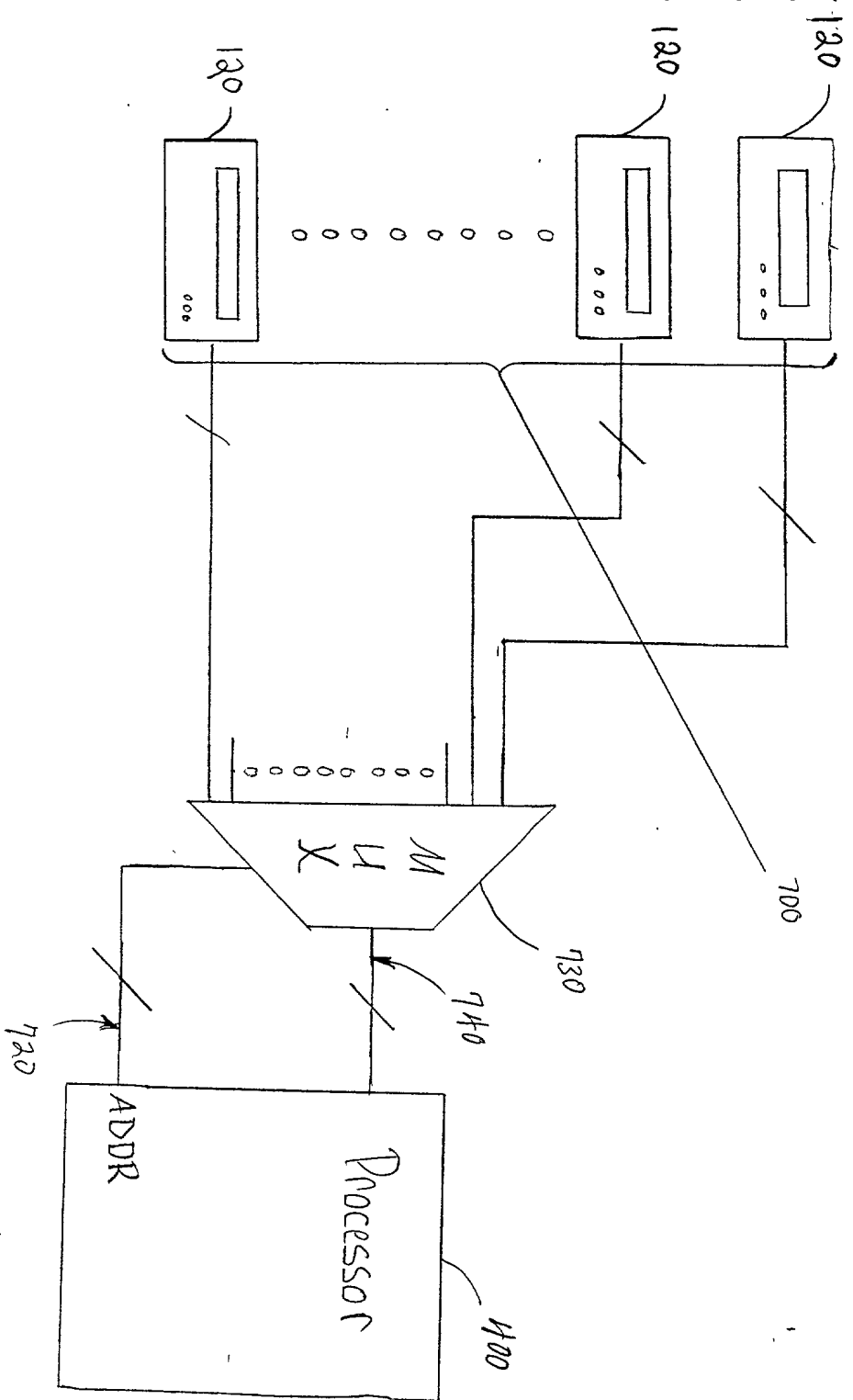


Fig. 7

00572000 00000000

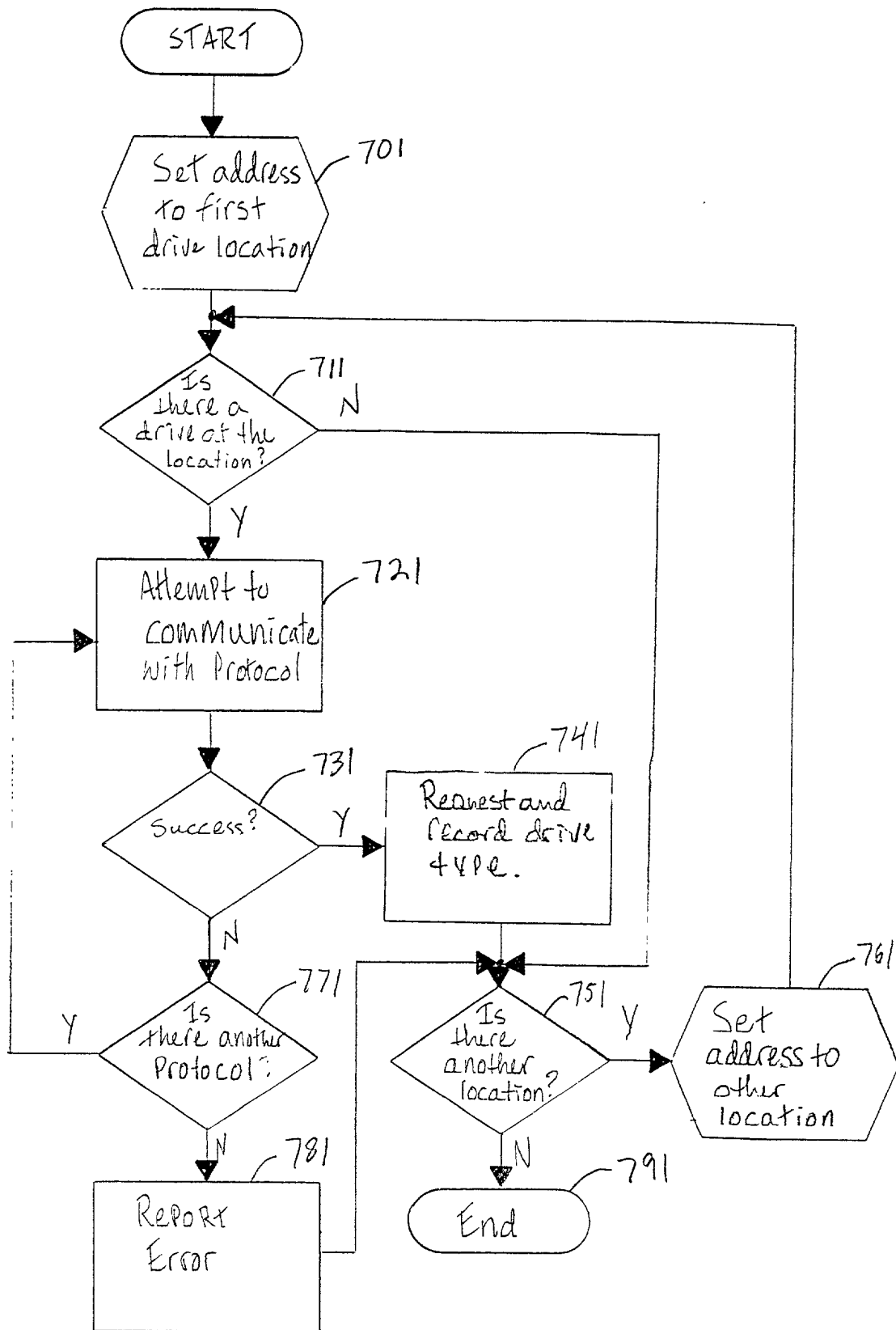


FIG. 7A

908



85

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Automated Hardware Sensing and Library Configuration

the specification of which (check one)

X is attached hereto.

_____ was filed on _____
as Application Serial No. _____
and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s): Priority Claimed

____ Yes ____ No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information material to the patentability of this application as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial #)	(Filing Date)	(Status)
------------------------	---------------	----------

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and

further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorneys and/or agents to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Wayne P. Bailey, Reg. No. 34,289; Timothy R. Schulte, Reg. No. 29,013; Duke W. Yee, Reg. No. 34,285; Colin P. Cahoon, Reg. No. 38,836; Stephen R. Loe, Reg. No. 43,757; Stephen J. Walder, Jr., Reg. No. 41,534; Charles D. Stepps, Reg. No. 45,880; and Stephen R. Tkacs, Reg. No. P-46,430.

Send correspondence to: Wayne P. Bailey, Storage Technology Corporation, One StorageTek Drive, Louisville, Colorado 80028-4309, and direct all telephone calls to Wayne P. Bailey, (303) 673-8223.

FULL NAME OF SOLE OR FIRST INVENTOR: Robert S. Creager

INVENTORS SIGNATURE: [Signature] DATE: 8/15/00

RESIDENCE: 6604 Kiva Ridge Drive
Berthoud, Colorado 80513

CITIZENSHIP: U.S.

POST OFFICE ADDRESS: SAME AS ABOVE

FULL NAME OF SECOND INVENTOR: James Ries

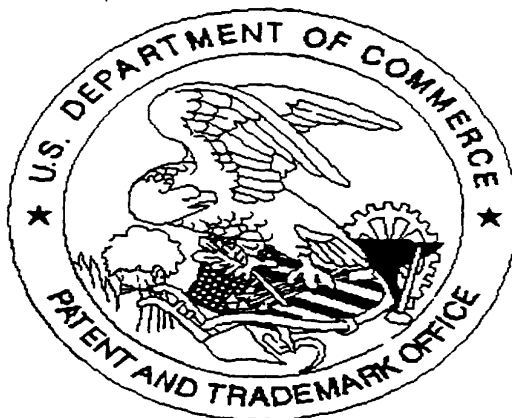
INVENTORS SIGNATURE: James Ries DATE: 8/15/00

RESIDENCE: 7345 Buckingham Road
Boulder, Colorado 80301

CITIZENSHIP: USA

POST OFFICE ADDRESS: SAME AS ABOVE

United States Patent & Trademark Office
Office of Initial Patent Examination -- Scanning Division



6743

Application deficiencies were found during scanning:

☒ Page(s) Fig. 1 of Drawing were not present
for scanning. skewed drawings (Document title)

☐ Page(s) _____ of _____ were not present
for scanning. (Document title)

☐ Scanned copy is best available.